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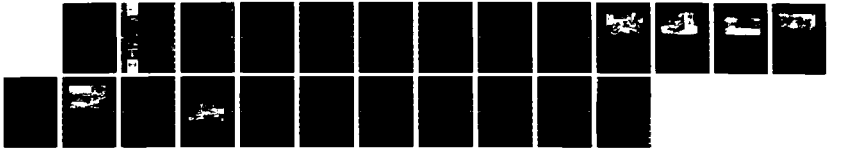

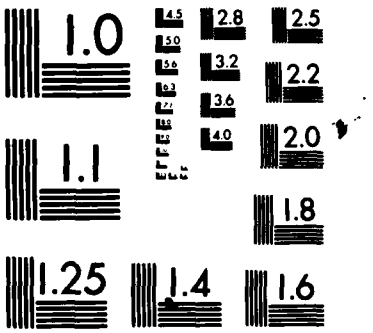

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MECHANICAL SITE PREPARATION TECHNIQUES

Section 5.7.1, US ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL

by

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A report on mechanical site preparation techniques is provided as Section 5.7.1 of the US Army Corps of Engineers Wildlife Resources Management Manual. The report was prepared as a guide to assist Corps biologists and resource managers in the use of site preparation techniques and associated equipment on project lands.

Habitat development and other revegetation projects often require mechanical site and seedbed preparation prior to and during planting operations. This report provides general information on mechanical techniques and major types of equipment used for these operations. Topics covered are dozers and attachments, chains and cables, choppers and shredders, mowers, plows and disks, sifters and harrows, subsoilers and rippers, furrowing and pitting, and regional considerations. A summary of basic equipment uses and limitations is provided in an appendix. The reader is referred to Chapter 8, EQUIPMENT, of this manual for more detailed information on individual pieces of equipment.

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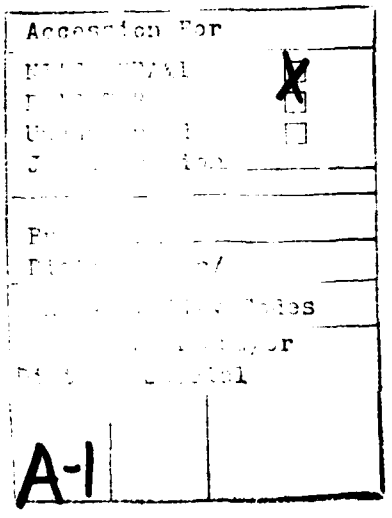

PREFACE

This work was sponsored by the Office, Chief of Engineers (OCE), US Army, as part of the Environmental Impact Research Program (EIRP), Work Unit 31631, entitled Management of Corps Lands for Wildlife Resource Improvement. The Technical Monitors for the study were Dr. John Bushman and Mr. Earl Eiker, OCE, and Mr. Dave Mathis, Water Resources Support Center.

This report was prepared by Mr. Ted B. Doerr, Range Science Department, Colorado State University, Fort Collins, Colo.; Dr. Mary C. Landin, Environmental Laboratory (EL), US Army Engineer Waterways Experiment Station (WES), and Mr. Chester O. Martin, EL, WES. Mr. Doerr was employed by WES under an Intergovernmental Personnel Act contract with Colorado State University during the period this report was prepared. Mr. Martin, Team Leader, Wildlife Resources Team, Wetlands and Terrestrial Habitat Group (WTHG), EL, was principal investigator for the work unit. Review and comments were provided by Mr. Larry E. Marcy, Texas A&M University, and Dr. Wilma A. Mitchell, WES.

The report was prepared under the general supervision of Dr. Hanley K. Smith, Chief, WTHG, EL; Dr. Conrad J. Kirby, Chief, Environmental Resources Division, EL; and Dr. John Harrison, Chief, EL. Dr. Roger T. Saucier, WES, was Program Manager, EIRP. The report was edited by Ms. Jessica S. Ruff of the WES Publications and Graphic Arts Division.

The authors wish to thank the following agencies and individuals for providing photographs used in the report: USDA Forest Service Equipment Development Center, Missoula, Mont.; Mr. Harold T. Wiedemann, Texas Agricultural Experiment Station, The Texas A&M University System, Vernon, Tex.; Mr. Steve Arrington, Rome Industries, Cedartown, Ga.; Dr. Edward F. Redente, Colorado State University, Fort Collins, Colo.; and Mr. David B. McMindes, Colorado Yampa Coal Company, Steamboat Springs, Colo.

At the time of publication, COL Allen F. Grum, USA, was Director of WES, and Dr. Robert W. Whalin was Technical Director.

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NOTE TO READER

This report is designated as Section 5.7.1 in Chapter 5 -- MANAGEMENT PRACTICES AND TECHNIQUES, Part 5.7 -- HABITAT MANIPULATION, of the US ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL. Each section of the manual is published as a separate Technical Report but is designed for use as a unit of the manual. For best retrieval, this report should be filed according to section number within Chapter 5.

MECHANICAL SITE PREPARATION TECHNIQUES

Section 5.7.1, US ARMY CORPS OF ENGINEERS
WILDLIFE RESOURCES MANAGEMENT MANUAL

Habitat development and other revegetation projects often require mechanical site and seedbed preparation prior to or during planting operations. General objectives usually are (1) control of existing or undesirable vegetation, (2) disruption of compacted soil, (3) removal of debris (i.e., stumps, rocks, and litter) to allow access and smooth operation of seeding or transplanting equipment, (4) smoothing and firming of the seedbed to improve seed/soil contact and promote even seed distribution, and (5) manipulation of the soil microtopography to improve stand establishment. Some techniques accomplish more than one objective by clearing debris, breaking up the soil, and incorporating organic matter, fertilizers, and seeds in a single operation.

This report provides general information on mechanical techniques and the major types of equipment used for site and seedbed preparation. Details on equipment designs, operation, maintenance, limitations, and availability are

given in Chapter 8, Equipment. The appendix provides a general summary of basic equipment uses and limitations discussed in the text.

DOZERS AND ATTACHMENTS

Dozers and various types of tractors can be used as the power source for site preparation. Dozers are more versatile for extensive site modification and can also be used to remove undesirable trees and shrubs. Attachments for dozers include (1) multipurpose blades with 4 digging teeth to cut trenches and uproot trees, shrubs, and rocks, (2) pushing blades to uproot and push over large trees, (3) cutting blades to shear off trees and shrubs at or below the soil surface, and (4) stacking rakes adapted for clearing small brush species or for stacking previously removed brush. Dozers are also frequently used for smoothing disturbed or eroded soil, building ponds and catchments, manipulating topsoil and soil dressings, clearing debris, and constructing temporary or permanent dikes, levees, and containments.

Blades and Rakes

Cutting blades and rakes are dozer attachments commonly used for site preparation. Cutting blades have a push bar at the top and a knife edge at the base for cutting trees up to 20 in. in diameter flush with the soil surface. Brush rakes are multitoothed pushing blades with gaps between the teeth that allow soil to sift through while gathering brush. In comparison with other types of blades, brush rakes prepare a better seedbed and result in less soil loss. Cutting blades and brush rakes should not be used in excessively rocky or shallow soils (Karsky 1979). They are well adapted for deeper soils in the Southeast and are used extensively for clearing and piling slash.

Grubbers

Power grubbers are modified dozer blades that are usually attached to a low-energy (65-hp) dozer (Fig. 1); high-energy (120-hp) dozers have been tested but are generally too costly and not as practical. Grubbers consist of a root cutting blade 35 in. long that can extend 6 to 12 in. below the soil surface. The equipment has been tested to efficiently remove root-sprouting shrubs and small trees up to 22 in. in diameter (Wiedemann et al. 1977, 1979; Wiedemann and Cross 1981; Wiedemann 1982). Power grubbers are most often used for land management in the West but are sometimes used by the timber industry in eastern states.

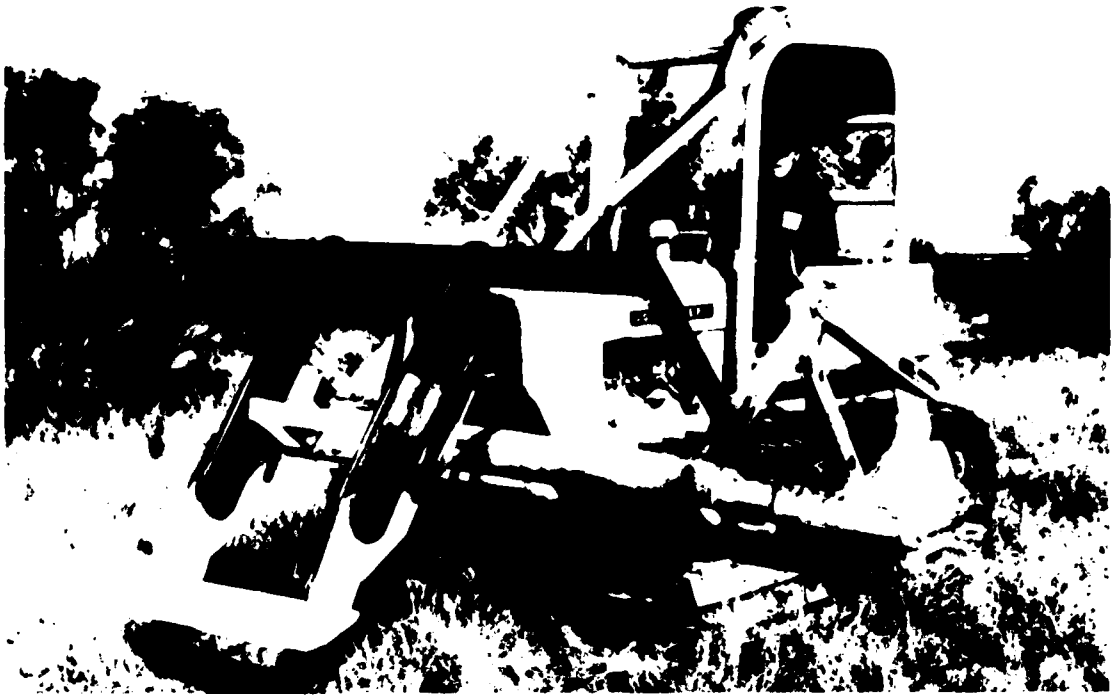

Figure 1. Low-energy power grubber (courtesy H. T. Wiedemann, Texas Agricultural Experiment Station)

Rootplows

Rootplows are rear-mounted dozer attachments that consist of a horizontal V-shaped blade mounted on 2 vertical bars; the blade can penetrate about 18 in. below the soil surface and slices roots below the budding zone (Fig. 2). Rootplowing is best adapted for shrub and small tree control but is not as effective as other techniques for removing large trees. Rootplows also reduce soil bulk density and increase water infiltration because their use greatly disturbs the soil A and B horizons. Disadvantages to the technique are that it destroys both desirable and undesirable vegetation and cannot be used on rocky, shallow soils. Seeding is required soon after treatment to reduce erosion (Larson 1980).

CHAINS AND CABLES

Chaining is an efficient way to remove dense stands of trees and brittle shrubs (up to 5500 trees/acre) on rangelands and is suitable for large acreages and most soils, including rocky sites. The technique consists of pulling a heavy anchor chain (22 to 77 lb/link) 100 to 500 ft between 2 dozers in a

Figure 2. Rootplow being used to control brush (courtesy H. T. Wiedemann, Texas Agricultural Experiment Station)

V- or J-shaped loop (Vallentine 1971, Larson 1980) (Fig. 3). Steel bars can be welded to links to increase soil scarification for seeding (Jensen 1969), and swivels have been used to allow the chain rotational freedom to keep it cleared of debris (Vallentine 1971). Chaining requires high power outputs, is inappropriate for use on root-sprouting species, and is ineffective on young, supple plants (Larson 1980).

Cabling is a variation of chaining that employs the use of a steel cable pulled between 2 dozers; the cables are usually 1.6 to 2.0 in. in diameter and 200 to 600 ft long. Cabling is better adapted for thinning, rather than the total elimination, of brush stands. The technique is ineffective on thickets and young plants. Chaining and cabling are seldom used in the eastern United States, especially in areas with more than 30 in. annual rainfall.

CHOPPERS AND SHREDDERS

Roller Choppers

Roller chopping is a technique used to control brittle shrubs and small trees up to 6 in. in diameter in the western states; choppers can be used on

Figure 3. Chaining operation using 2 dozers (courtesy USDA Forest Service, Missoula, Montana)

slopes as steep as 35% when pulled on the contour (Larson 1980). This technique employs a steamroller drum with chopper blades on the outer surface pulled behind a dozer, thereby cutting and crushing the vegetation. The weight of the drum can be varied by filling with water to different levels. Choppers also act as imprinters, making small depressions in the soil surface that increase infiltration and water retention. Roller chopping is not effective on root-sprouting species, and the drum can be damaged by large rocks.

Shredders

Shredders (including rotobeaters) are designed to cut brush, handle slash on the ground, and chop the material into mulch (Fig. 4). Most available rotobeaters can handle stumps up to 2 in. in diameter (Larson 1980), and tests in Colorado showed that a Madge Roto-Clear can easily chop aspen (*Populus* spp.) up to 9.8 in. in diameter. The machine can also chop shrub thickets of Gambel's oak (*Quercus gambelii*) and chokecherry (*Prunus virginiana*) into 4- to 6-in. pieces and incorporate them into the upper 6 to 9 in. of the soil. Shredders and rotobeaters are not adapted to steep slopes or rocky soils, can be expensive to operate, and require large amounts of power.

Figure 4. Rotobeater shredder pulled by a dozer (courtesy David B. McMindes, Colorado Yampa Coal Co.)

Bush Hogs

Bush hogs are heavy-duty rotary cutters that are usually pulled behind a tractor. They are used primarily in the East to clear thickets and old fields and to produce stubble mulch on agricultural lands. They are equipped with 1 to 3 large blades, depending on the width of the brush hog, and are capable of chopping up to 4-in.-diam trees. Bush hogs 5 to 7 ft wide can be operated with less than 60-hp wheeled tractors, whereas those up to 15 ft wide require larger, higher energy tractors. Bush hogs are hydraulically powered and very durable. An advantage of smaller models is that they can be hydraulically lifted by the tractor, thus making it easier to maneuver into small corners and around vegetation.

A modification of the standard bush hog is the side-mounted hog that can be hydraulically lifted up to 15 ft for pruning tree limbs and shrubs. This implement is used primarily on steep slopes, roadsides, ditch and creek banks, and around bridge abutments and highway safety structures.

MOWERS

Mowers are commonly used on project lands for periodic maintenance of roadsides, levees, recreational sites, meadows, and other special use areas. Mowing can also help control weed competition on newly seeded sites and provides a better soil-moisture regime for germination and emergence. Mowing generally creates conditions that favor perennial plants with spreading root systems over less desirable annual species.

The general types of mowers commercially available include flail, rotary, reel, and sickle bar mowers. Flail mowers cut by impacting vegetation with a downward movement of cutting knives; rotary mowers also cut by impact, but the blades move horizontally. Reel mowers cut by slicing in a downward movement, and sickle bar mowers use a scissor-like cut parallel with the ground (White and Bailey 1968). Each type of mower has certain advantages and limitations with respect to power requirements, height settings, durability, and site adaptability. All types are powered by a hydraulic or power-take-off (PTO) system.

PLOWS AND DISKS

Disking, chiseling, and harrowing are techniques used to reduce shallow soil compaction, remove undesirable shrubs and herbaceous species, incorporate soil amendments, and prepare the seedbed. Disks, brushland plows, and chisel plows are discussed below.

Plows and Disk Harrows

Plows operate by moving soil in one direction using a single set of disks, whereas disk harrows have 2 sets of disks that move the soil in opposing directions (Ray 1977). Standard or one-way and brushland plows are designed for deep furrowing on level to gently sloping lands and agricultural soils free of rocks and debris (Larson 1980). They effectively turn the soil over but are not as efficient as disk harrows in mixing soil. Disk harrows (off-set or two-way disks) can be adapted for deep plowing and brush control, for conventional plowing, and for pulverizing the soil surface (Ray 1977) (Fig. 5). They are also used to control herbaceous weeds and to incorporate mulch and fertilizers into the soil. Disk-chains are 36-in. disks welded on an anchor chain and pulled between 2 dozers. This technique reduces the cost of seedbed preparation to one-half that of using a conventional disk (Wiedemann and Cross 1981, Wiedemann and McKenzie 1982).

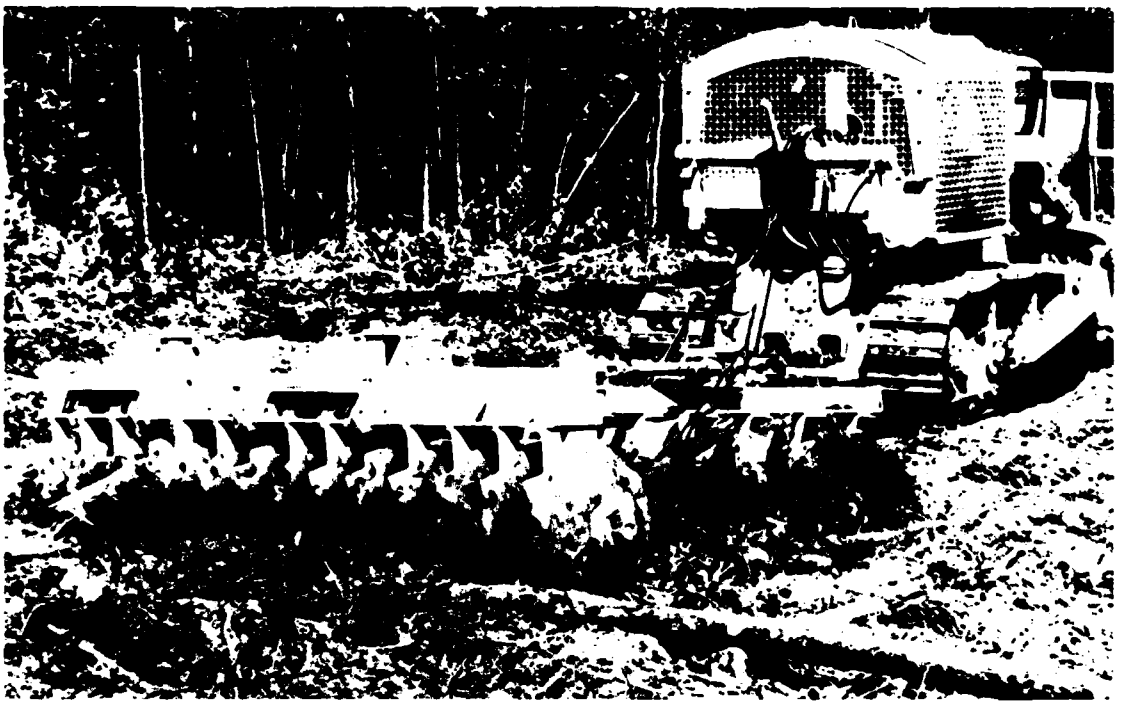

Figure 5. Disk harrow being used to prepare a seedbed (courtesy Steve Arrington, Rome Industries)

Disk Plows

The term "disk plow" is used here to refer to brushland and chisel plows. The brushland plow is a large, heavy-duty disk specifically designed for rangeland plowing. Designed by the USDA Forest Service, it controls shrubs up to 2 in. in diameter and is effective on rough, rocky terrain (Larson 1980). Each disk pair is mounted on a spring-loaded arm for separate articulation; thus, the disks travel over rocks and stumps independently, which minimizes the chance of breakage. Disadvantages of the brushland plow include high initial cost, low availability, difficulty in transporting because of size and weight, and shallow disking (4-in.) capability (Vallentine 1971, Larson 1980).

Chisel plows have curved blades attached to a frame, and each blade is spring-loaded to go over rocks independently (Larson 1980). However, these plows do not perform well on rocky soils (Brown 1977) and are not appropriate for brush control. Chisel plows are used to reduce surface compaction, incorporate soil amendments, and improve aeration and water infiltration.

SIFTERS AND HARROWS

Other implements that are used to prepare a clean seedbed or incorporate amendments into the soil include soil sifters, harrows, and klodbusters. Most of these devices are frequently used in agricultural practices but are not suitable for rocky terrain.

Soil Sifters

Soil sifters are used to separate rocks, roots, and brush from the soil and to deposit debris in windrows (Larson 1980). They are used in conjunction with brush control techniques such as root plowing but are not adapted to shallow, rocky soils. Soil sifters are also used regularly on clean agricultural lands to pulverize soil clods and form an even seedbed. Seeding is required soon after sifting to minimize erosion. Soil sifters are still being modified for greater reliability in brushlands, and their availability is currently limited.

Harrows

Several types of harrows are available, including spike-toothed and spring-toothed harrows. Spike-toothed harrows can be used to prepare seedbeds for drill seeding or to cover broadcasted seed. They do not penetrate the soil and, therefore, cannot be used for any purpose other than topdressing areas. Spring-toothed harrows are used to incorporate fertilizers into the soil and to control weedy annuals; they are also suited for secondary tillage of rocky areas where plows are ineffective. However, they break down easily on extremely rocky and rough terrain and must be cleaned regularly on areas with heavy debris.

Klodbusters

Klodbusters are chain implements with 6-in. steel bars welded at right angles to the chain at 7.8-in. intervals (Larson 1980); a weighted slope wheel is attached at the opposite end from a pulling tractor. Klodbusters are efficient devices for preparing seedbeds on steep slopes in excess of 20%. They are designed for nonagricultural slope use only, and the area must be free of stumps and large rocks.

SUBSOILERS AND RIPPERS

Areas with deep soil compaction or impermeable soil layers and hardpans may need to be treated with subsoilers or rippers to improve water movement, root growth, and depth of root penetration (Larson 1980). Subsoilers and rippers are rear-mounted on dozers or large tractors and consist of stout, curved shanks that can penetrate the soil surface in excess of 36 in. (Fig. 6). These implements have high power requirements and are inappropriate on steep slopes and rocky soils. Ripping also requires additional seedbed preparation for seeding to be successful. Intensively cultivated land and meadows should be subsoiled on a regular basis to improve crop and forage yields and grass production.

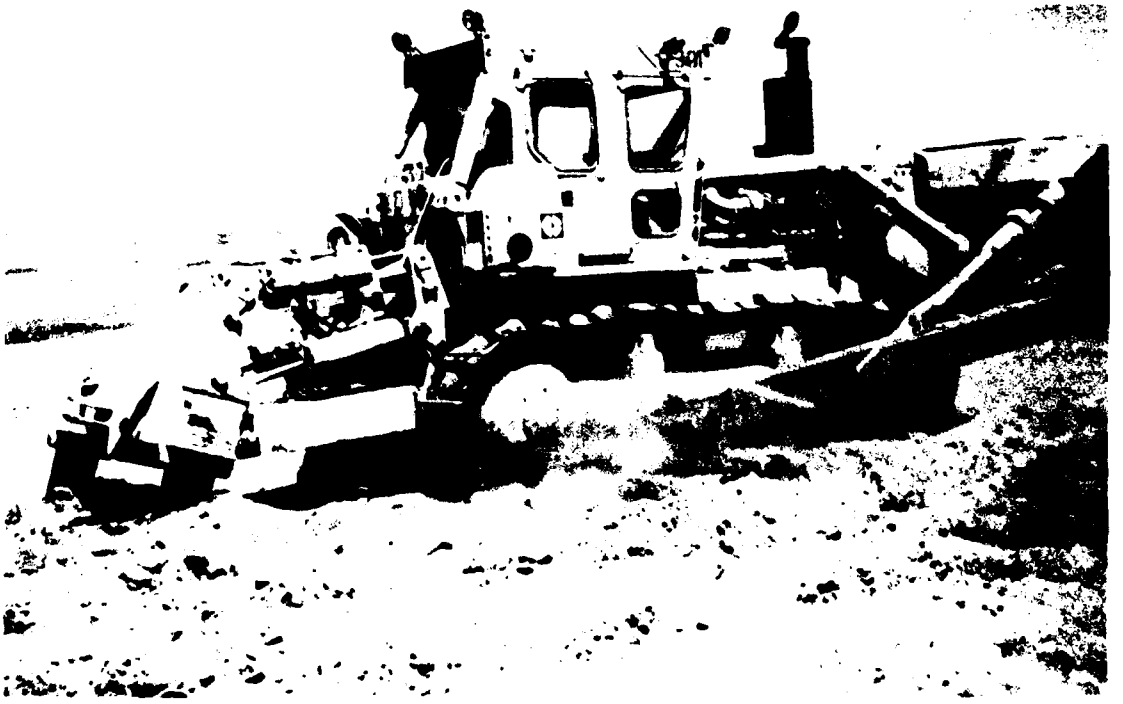

Figure 6. Ripper being used to alleviate soil compaction (courtesy Dr. E. F. Redente, Colorado State University)

FURROWING AND PITTING

Selected techniques used to manipulate soils on arid and semiarid lands include furrowing, pitting, gouging, terracing, and basin forming. These treatments are used to improve infiltration, increase runoff retention, decrease erosion, and improve forage yields.

Furrowing

Contour furrowing has been used in the Great Plains, Southwest, and Intermountain West. This technique has been shown to reduce sedimentation loss, increase moisture retention, and increase grass production. Furrows 24 to 60 in. apart, 18 to 32 in. wide, and 4 in. deep are recommended for contour furrowing (Vallentine 1971, Larson 1980). Furrows are made with a Model B subsoiler, which consists of a pair of small subsoiler blades set shallowly to reduce compaction; these blades are followed by two 26-in. disks per subsoiler to cut the furrows. The disks are each followed by a paddlewheel assembly that creates a soil dam at intervals in the trench for sediment impoundment (Larson 1980). Seedboxes can also be mounted on this assembly.

Contour trenchers are similar to contour furrowers but form deeper trenches and are used specifically on steep slopes that are not greater than 40% to 45%. Trenchers have two disks 28 to 32 in. in diameter mounted behind a bulldozer; these implements can cut a trench 12 in. deep and 24 in. wide. Furrowing and trenching are less frequently used in the eastern states but have wide applicability on deep, sloped soils and strip-mined sites.

Pitting

Pitting is an economical technique that provides small pits or basins to hold rain and runoff water (Vallentine 1971). The technique has been successfully used in the Southwest and Great Plains region and is most appropriate for gently sloped rangelands. Several types of equipment are available for pitting, including disk pitters, rotary drum pitters, imprinters, and rotary pitters. Pits last 3 to 5 years on loose or coarse-textured soils (Barnes et al. 1958) and can last 15 years on medium- or fine-textured soils (Rauzi 1968). Plant competition must be controlled for pitting to improve newly seeded stands or older, established stands in poor condition (Vallentine 1971).

Disk imprinters are rotary disks that are notched or offset to provide intermittent soil contact for pit formation. Rotary drum and rotary pitters have curved, stout blades set on a drum (rotary-drum pitter) or on wheels (rotary pitter). The imprinter is built on a steamroller drum fitted with geometric imprinting pads and is pulled by a dozer. It is similar to a rollerchopper except that pads are used rather than blades.

Gouging

Gouging is similar to pitting in that small soil depressions are made to increase soil moisture and create microsites for plant establishment on relatively level areas. The modified hodder gouger has been demonstrated to be useful for revegetating disturbed lands (Knudson 1977). The gouger has 3 toothed blades that are hydraulically raised and lowered to form pits. Seeds can be broadcast at the same time pits are being created by mounting a seedbox behind the gouger.

Terracing and Basin Forming

Terracing is an expensive technique that requires careful engineering and implementation. Terracing increases water retention, reduces soil erosion, and increases plant production on deeper soils; however, it has not proven successful in increasing perennial grass production on shallow soils. Basin blades provide large soil depressions that are appropriate for erosion control on slopes (Karsky 1979), and they overcome problems with high costs and implementation, which are the major drawbacks of terraces. The basin blade is rear-mounted on a dozer and consists of a 9.8-ft-wide blade with 2-in.-wide teeth mounted on the bottom using shear bolts. It is operated hydraulically and has a motion similar to a backhoe. Availability of basin blades is currently limited, and the equipment may have to be custom built.

REGIONAL CONSIDERATIONS

The suitability of a particular piece of equipment for project use will depend upon a variety of factors, including cost, availability, personnel requirements for operation and maintenance, storage requirements, amount of land to be treated, objectives of treatment, and regional and site-specific habitat characteristics. Most types of equipment are marketed in a variety of brands and sizes, and the project manager will often need to do a considerable amount of comparative shopping to select the model that best suits his needs.

Many of the previously discussed techniques and types of equipment were designed primarily for use on larger acreages in the western and central states. However, a variety of implements such as grubbers, rootplows, mowers, disks, harrows, and shredders have wide application for site and seedbed preparation in most regions. Revegetation projects in the East and Southeast are often small parcels of land where the use of heavy-duty equipment usually is

not practical or cost effective; therefore, standard and/or modified agricultural and horticultural implements designed to be pulled by rubber-tired tractors will be most effective in these regions. Small dozers and bush hogs are often appropriate for habitat manipulation on small acreages, especially on deeper soils where high-energy outputs are not required for operation.

Site preparation techniques described in this report have limited application for habitat development in coastal regions, although modified dozers are often used for land-shaping operations in dredged material management and coastal erosion projects. Techniques in coastal areas and on moist soils often require the use of hand-held equipment or lightweight implements pulled by small tractors or jeeps. Specialized techniques are discussed in other sections of this chapter and in Chapter 8, Equipment.

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APPENDIX

Summary of Capabilities and Limitations for Site Preparation Equipment

Equipment	Site Preparation	Capabilities	Limitations	Power Requirements
Dozer blades	Brush clearing	Removal of stumps and large trees.	Does not control rhizomatous and stump-sprouting species. Not suited for shallow or rocky soils. Least efficient clearing method.	39-700 hp
Grubbers	Brush control	Removal of individual rhizomatous and stump-sprouting species.	Not appropriate for dense stands.	65-200 hp
Root plows	Brush control	Control of stump-sprouting species on large areas.	Areas must be reseeded to increase herbaceous production.	60-170 hp
Chains and cables	Brush control	Preparation of rough seedbed for broadcast seeding or covering seed. Thins or clears dense extensive mature tree stands. Most economical tree-felling method.	Limited to tree diameters from 6 to 24 in. Does not severely affect undergrowth with flexible stems. Does not control rhizomatous species.	190-290 hp
Rotobeaters, shredders, and bush hogs	Brush control	Used to shred woody vegetation and create a mulch material.	Not appropriate for rocky, shallow soils. High maintenance requirements.	60-250 hp
Roller choppers	Brush control	Used to crush and chop nonroot-sprouting species.	Surface treatment only. Not appropriate for rocky soils. Does not control rhizomatous species.	60-370 hp
Mowers	Herbaceous weed control	Removal of top growth. Can reduce seed production.	Not generally suited for woody vegetation. Limited application on nonintensive management areas.	60-84 hp
Standard and one-way disks	Seedbed preparation	Used for normal and deep plowing, and herbaceous weed control.	Not suited for rocky or uneven terrain.	20-215 hp
Offset and tandem disks	Seedbed preparation	Capable of removing sparse brush. Useful for deep plowing dry, heavy soils.	Not suited for rocky or uneven terrain.	60-315 hp
Brushland plows	Brush control, Seedbed preparation	Suited for plowing rocky soils on uneven terrain and destroying brush.	Not widely available. Initial cost is high. Difficult to transport.	40-124 hp
Disk-chains	Seedbed preparation	Good for herbaceous weed control and primary tilling.	Must be relatively brush and rock free; not widely available.	300 hp
Chisel plows	Seedbed preparation	Used to relieve shallow compaction. Incorporates fertilizers and mulch.	Furrows do not last long.	30-315 hp
Subsoilers and rippers	Soil compaction	Used to alleviate deep soil compaction. Creates deep furrows.	Not appropriate for rocky soils or steep slopes.	55-315 hp
Soil sifters	Seedbed preparation	Used to clear stumps, logs, and other debris; reduces large soil clumps.	Must reseed rapidly to avoid erosion. Not suited for highly rocky soils.	100 hp

(Continued)

Appendix (Concluded)

Equipment	Site Preparation	Capabilities	Limitations	Power Requirements
Disk harrows	Secondary seedbed preparation	Used to control annual vegetation and incorporate soil amendments.	Not adapted to rough, rocky, uneven terrain.	40-315 hp
Spike-toothed harrows	Secondary seedbed preparation	Used to smooth roughly plowed soils. Useful on debris-laden soils and for covering broadcast seed.	Provides a surface treatment only. Not adapted to rough terrain.	+20 hp
Spring-toothed harrows	Secondary seedbed preparation	Used to incorporate soil amendments and smooth moderately rocky and debris-laden soils.	Not adapted to extremely rough range sites without prior brush control and site preparation.	20-315 hp
Klodbusters	Steep-slope seedbed preparation	Adapted for preparing steep slopes for broadcast seeding and hydroseeding.	Slopes must be in excess of 20 percent.	low
Furrowers and trenchers	Erosion control	Used to create furrows that collect moisture and improve infiltration. Trenchers are useful on slopes up to 45%.	Furrows must be on the contour. Furrows must last to be useful. Furrowers should not be used on slopes greater then 20 percent.	42-60 hp (trenchers) 55-120 hp (furrows)
Land imprinters	Seed environment improvement	Used to create small pits for moisture collection and improved infiltration. Useful on rough land, up to 45% slope. Soil structure is not completely destroyed.	Cannot be used on dense brushy areas.	60-105 hp
Gougers and pitters	Seed environment improvement	Used to create small pits to collect moisture and increase infiltration.	Not adapted to slopes greater than 20%.	+50 hp
Basin blades	Seed environment improvement, erosion control	Used to create large basins (pits) for moisture collection and soil moisture concentration; best on slopes.	Low availability. High initial cost. Other techniques better on level ground.	290-370 hp

END

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